

# Aris T. Allen Boulevard Residential Development

Located In:  
Annapolis, Maryland

## Stormwater Management Report

Prepared For:  
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### Professional Certification:

I hereby certify that these documents were prepared or approved by me, and that I am a duly licensed Professional Engineer under the laws of the State of Maryland.

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## **NARRATIVES**

## **INTRODUCTION & SITE INFORMATION**

The Aris T. Allen property encompasses approximately 23 acres located in land annexed into the City of Annapolis, from Anne Arundel County. Approximately 9 acres of this land will be developed and the rest will be conserved. More specifically, the property is located just south of Aris T. Allen Boulevard (Rt. 665) and approximately 0.75 miles east of Solomons Island Road, and is bordered by residential developments to the east and south. The site is located within the Severn watershed, and drains to an unnamed tributary to Church Creek.

Currently the site is primarily wooded and undeveloped, and is zoned R-1, R-1A, and R1-B. The applicant proposes a mixed residential development consisting of single family and townhouse units. Stormwater management will be address for the site as detailed below.

Existing soil types are either classified as HSG Type 'B' or Type 'C'. The site is partially located within the 100-year floodplain, and wetland areas have also been identified on-site. There are no known historical and/or archaeological resources within the project limits. Offsite areas will be protected from sedimentation by installation of perimeter erosion controls, within the proposed limits of disturbance.

The existing site is 1% impervious and does not qualify as redevelopment. Thus, the proposed stormwater facilities must be designed to meet full ESD requirements. The proposed development will result in 49% impervious cover (within the limit of disturbance) on the site and will provide stormwater management controls in accordance with current Maryland Department of the Environment (MDE) requirements.

## **HYDROLOGY**

Stormwater management requirements are based upon the *2000 Maryland Stormwater Design Manual Volumes I and II*, as supplemented by the 2009 *Environmental Site Design* requirements. Stormwater runoff computations have been performed with the Rational Formula.

## **STORMWATER MANAGEMENT REQUIREMENTS**

The Maryland Department of the Environment (MDE) 2009 *Environmental Site Design* (ESD) requirements applies to this project. New developments must meet criteria for Recharge Volume (Rev), Water Quality Volume (WQv) and Channel Protection Volume (Cpv). Overbank Flood Protection (Qp) and Extreme Flood Control (Qf) are evaluated on a project-by-project basis in accordance with requirements of the local approving authorities, in this case the City of Annapolis. Full ESD design requirements apply to this site.

## ESD COMPUTATIONS

### Existing Conditions

Limit of Disturbed Area (LOD): 402,798 SF, 9.25 Ac.

Existing Impervious Area within LOD: 4,565 SF, 0.10 Ac.

Percent Impervious:  $4,565 \text{ SF} / 402,798 \text{ SF} = \mathbf{1\% (<40\%)}$

Project does not meet redevelopment criteria; therefore, full ESD required

### Proposed Site Conditions

Limit of Disturbed Area: 402,798 SF, 9.25 Ac.

Impervious Area within LOD = 195,416 SF, 4.49 Ac.

% Impervious = 49% (Use 50% for Pe)

### Preliminary ESDv Calculations (Type 'B' Soils):

From ESD Chapter 5, Table 5.3, Target Pe (Type 'B' Soils) = **1.8"**

From ESD Chapter 5, Table 5.3, Target Pe (Type 'C' Soils) = **1.8"**

$R_v = 0.05 + 0.009(I) = 0.05 + 0.009(49) = \mathbf{0.49}$

For Full ESDV:

$$\text{ESDv} = \frac{(1.8'')(0.49)(402,798)}{12} = 29,606 \text{ CF}$$

Required Grand Total ESDv = **29,606 CF**

## PROPOSED ESD FACILITIES AND PROVIDED ESD VOLUME

1. Drywells – these subsurface gravel chambers are proposed to store and infiltrate rooftop runoff from the townhouses on the north end of the site, and a few of the single family homes on the southern part of the site. Each proposed drywell, for this project, is capable of storing 106 cubic feet of ESD volume.

The dimensions of the drywells are as follows:

L = 11 Ft.

W = 5 Ft.

H = 5 Ft.

Porosity (n) of gravel = 0.40 (40%)

Storage volume within each drywell:

ESDv = (5)(11)(5)(0.40) = 110 CF; However, the volume stored for each drywell is limited by a maximum Pe of 2.7". 2.7" of runoff over 500 SF of roof drainage area will yield only 106 CF of runoff, and therefore, each drywell is capable of storing a maximum of 106 CF of ESD volume. See calculations below for actual ESDv provided by this BMP.

45 drywells are proposed site wide in order to limit roof drainage areas to 500 SF or less. Calculations for ESDv provided are presented below for each individual lot and then totaled:

Lot 1:

Roof Drainage Area = 1,000 SF; therefore 2 drywells are proposed, with 500 SF of roof area draining to each.

$$I = 100\%$$

$$R_v = 0.95$$

$$P_e = 1.0'' \text{ min./ } 2.7'' \text{ max.}$$

$$\text{ESDv(min)} = \frac{(1.0'')(0.95)(1,000)}{12} = 79 \text{ CF}$$

$$\text{ESDv(max)} = \frac{(2.7'')(0.95)(1,000)}{12} = 213 \text{ CF}$$

$$\text{ESDv Provided} = \underline{212 \text{ CF}}$$

Lot 2:

Roof Drainage Area = 482 SF; therefore 1 drywell is proposed.

$$I = 100\%$$

$$R_v = 0.95$$

$$P_e = 1.0'' \text{ min./ } 2.7'' \text{ max.}$$

$$\text{ESDv(min)} = \frac{(1.0'')(0.95)(482)}{12} = 38 \text{ CF}$$

$$\text{ESDv(max)} = \frac{(2.7'')(0.95)(482)}{12} = 103 \text{ CF}$$

$$\text{ESDv Provided} = \underline{103 \text{ CF}}$$

Lot 3:

Roof Drainage Area = 358 SF; therefore 1 drywell is proposed.

I = 100%

Rv = 0.95

Pe = 1.0" min./ 2.7" max.

$$\text{ESDv}(\text{min}) = \frac{(1.0'')(0.95)(358)}{12} = 28 \text{ CF}$$

$$\text{ESDv}(\text{max}) = \frac{(2.7'')(0.95)(358)}{12} = 76 \text{ CF}$$

ESDv Provided = 76 CF

Lot 4:

Roof Drainage Area = 482 SF; therefore 1 drywell is proposed.

I = 100%

Rv = 0.95

Pe = 1.0" min./ 2.7" max.

$$\text{ESDv}(\text{min}) = \frac{(1.0'')(0.95)(482)}{12} = 38 \text{ CF}$$

$$\text{ESDv}(\text{max}) = \frac{(2.7'')(0.95)(482)}{12} = 103 \text{ CF}$$

ESDv Provided = 103 CF

Lot 5:

Roof Drainage Area = 358 SF; therefore 1 drywell is proposed.

I = 100%

Rv = 0.95

Pe = 1.0" min./ 2.7" max.

$$\text{ESDv}(\text{min}) = \frac{(1.0'')(0.95)(358)}{12} = 28 \text{ CF}$$

$$\text{ESDv}(\text{max}) = \frac{(2.7'')(0.95)(358)}{12} = 76 \text{ CF}$$

ESDv Provided = 76 CF

Lot 6:

Roof Drainage Area = 482 SF; therefore 1 drywell is proposed.

I = 100%

Rv = 0.95

Pe = 1.0" min./ 2.7" max.

$$\text{ESDv(min)} = \frac{(1.0'')(0.95)(482)}{12} = 38 \text{ CF}$$

$$\text{ESDv(max)} = \frac{(2.7'')(0.95)(482)}{12} = 103 \text{ CF}$$

ESDv Provided = 103 CF

Lot 7:

Roof Drainage Area = 500 SF; therefore 1 drywell is proposed.

I = 100%

Rv = 0.95

Pe = 1.0" min./ 2.7" max.

$$\text{ESDv(min)} = \frac{(1.0'')(0.95)(500)}{12} = 40 \text{ CF}$$

$$\text{ESDv(max)} = \frac{(2.7'')(0.95)(500)}{12} = 103 \text{ CF}$$

ESDv Provided = 103 CF

Lot 8:

Roof Drainage Area = 500 SF; therefore 1 drywell is proposed.

I = 100%

Rv = 0.95

Pe = 1.0" min./ 2.7" max.

$$\text{ESDv(min)} = \frac{(1.0'')(0.95)(500)}{12} = 40 \text{ CF}$$

$$\text{ESDv(max)} = \frac{(2.7'')(0.95)(500)}{12} = 103 \text{ CF}$$

ESDv Provided = 103 CF

Lot 9:

Roof Drainage Area = 482 SF; therefore 1 drywell is proposed.

I = 100%

Rv = 0.95

Pe = 1.0" min./ 2.7" max.

$$\text{ESDv(min)} = \frac{(1.0'')(0.95)(482)}{12} = 38 \text{ CF}$$

$$\text{ESDv(max)} = \frac{(2.7'')(0.95)(482)}{12} = 103 \text{ CF}$$

ESDv Provided = 103 CF

Lot 10:

Roof Drainage Area = 358 SF; therefore 1 drywell is proposed.

I = 100%

Rv = 0.95

Pe = 1.0" min./ 2.7" max.

$$\text{ESDv(min)} = \frac{(1.0'')(0.95)(358)}{12} = 28 \text{ CF}$$

$$\text{ESDv(max)} = \frac{(2.7'')(0.95)(358)}{12} = 76 \text{ CF}$$

ESDv Provided = 76 CF

Lot 11:

Roof Drainage Area = 482 SF; therefore 1 drywell is proposed.

I = 100%

Rv = 0.95

Pe = 1.0" min./ 2.7" max.

$$\text{ESDv(min)} = \frac{(1.0'')(0.95)(482)}{12} = 38 \text{ CF}$$

$$\text{ESDv(max)} = \frac{(2.7'')(0.95)(482)}{12} = 103 \text{ CF}$$

ESDv Provided = 103 CF

Lot 12:

Roof Drainage Area = 482 SF; therefore 1 drywell is proposed.

I = 100%

Rv = 0.95

Pe = 1.0" min./ 2.7" max.

$$\text{ESDv(min)} = \frac{(1.0'')(0.95)(482)}{12} = 38 \text{ CF}$$

$$\text{ESDv(max)} = \frac{(2.7'')(0.95)(482)}{12} = 103 \text{ CF}$$

ESDv Provided = 103 CF

Lot 13:

Roof Drainage Area = 500 SF; therefore 1 drywell is proposed.

I = 100%

Rv = 0.95

Pe = 1.0" min./ 2.7" max.

$$\text{ESDv(min)} = \frac{(1.0'')(0.95)(500)}{12} = 40 \text{ CF}$$

$$\text{ESDv(max)} = \frac{(2.7'')(0.95)(500)}{12} = 103 \text{ CF}$$

ESDv Provided = 103 CF

Lot 14:

Roof Drainage Area = 500 SF; therefore 1 drywell is proposed.

I = 100%

Rv = 0.95

Pe = 1.0" min./ 2.7" max.

$$\text{ESDv(min)} = \frac{(1.0'')(0.95)(500)}{12} = 40 \text{ CF}$$

$$\text{ESDv(max)} = \frac{(2.7'')(0.95)(500)}{12} = 103 \text{ CF}$$

ESDv Provided = 103 CF

Lot 15:

Roof Drainage Area = 482 SF; therefore 1 drywell is proposed.

I = 100%

Rv = 0.95

Pe = 1.0" min./ 2.7" max.

$$\text{ESDv}(\min) = \frac{(1.0'')(0.95)(482)}{12} = 38 \text{ CF}$$

$$\text{ESDv}(\max) = \frac{(2.7'')(0.95)(482)}{12} = 103 \text{ CF}$$

ESDv Provided = 103 CF

Lot 16:

Roof Drainage Area = 358 SF; therefore 1 drywell is proposed.

I = 100%

Rv = 0.95

Pe = 1.0" min./ 2.7" max.

$$\text{ESDv}(\min) = \frac{(1.0'')(0.95)(358)}{12} = 28 \text{ CF}$$

$$\text{ESDv}(\max) = \frac{(2.7'')(0.95)(358)}{12} = 76 \text{ CF}$$

ESDv Provided = 76 CF

Lot 17:

Roof Drainage Area = 482 SF; therefore 1 drywell is proposed.

I = 100%

Rv = 0.95

Pe = 1.0" min./ 2.7" max.

$$\text{ESDv}(\min) = \frac{(1.0'')(0.95)(482)}{12} = 38 \text{ CF}$$

$$\text{ESDv}(\max) = \frac{(2.7'')(0.95)(482)}{12} = 103 \text{ CF}$$

12

ESDv Provided = 103 CF

Lot 18:

Roof Drainage Area = 482 SF; therefore 1 drywell is proposed.

I = 100%

Rv = 0.95

Pe = 1.0" min./ 2.7" max.

$$\text{ESDv(min)} = \frac{(1.0'')(0.95)(482)}{12} = 38 \text{ CF}$$

$$\text{ESDv(max)} = \frac{(2.7'')(0.95)(482)}{12} = 103 \text{ CF}$$

ESDv Provided = 103 CF

Lot 19:

Roof Drainage Area = 500 SF; therefore 1 drywell is proposed.

I = 100%

Rv = 0.95

Pe = 1.0" min./ 2.7" max.

$$\text{ESDv(min)} = \frac{(1.0'')(0.95)(500)}{12} = 40 \text{ CF}$$

$$\text{ESDv(max)} = \frac{(2.7'')(0.95)(500)}{12} = 103 \text{ CF}$$

ESDv Provided = 103 CF

Lot 20:

Roof Drainage Area = 500 SF; therefore 1 drywell is proposed.

I = 100%

Rv = 0.95

Pe = 1.0" min./ 2.7" max.

$$\text{ESDv(min)} = \frac{(1.0'')(0.95)(500)}{12} = 40 \text{ CF}$$

$$\text{ESDv(max)} = \frac{(2.7'')(0.95)(500)}{12} = 103 \text{ CF}$$

$$\text{ESDv Provided} = \underline{103 \text{ CF}}$$

Lot 21:

Roof Drainage Area = 482 SF; therefore 1 drywell is proposed.

$$I = 100\%$$

$$R_v = 0.95$$

$$P_e = 1.0'' \text{ min./ } 2.7'' \text{ max.}$$

$$\text{ESDv(min)} = \frac{(1.0'')(0.95)(482)}{12} = 38 \text{ CF}$$

$$\text{ESDv(max)} = \frac{(2.7'')(0.95)(482)}{12} = 103 \text{ CF}$$

$$\text{ESDv Provided} = \underline{103 \text{ CF}}$$

Lot 22:

Roof Drainage Area = 358 SF; therefore 1 drywell is proposed.

$$I = 100\%$$

$$R_v = 0.95$$

$$P_e = 1.0'' \text{ min./ } 2.7'' \text{ max.}$$

$$\text{ESDv(min)} = \frac{(1.0'')(0.95)(358)}{12} = 28 \text{ CF}$$

$$\text{ESDv(max)} = \frac{(2.7'')(0.95)(358)}{12} = 76 \text{ CF}$$

$$\text{ESDv Provided} = \underline{76 \text{ CF}}$$

Lot 23:

Roof Drainage Area = 482 SF; therefore 1 drywell is proposed.

$$I = 100\%$$

$$R_v = 0.95$$

$$P_e = 1.0'' \text{ min./ } 2.7'' \text{ max.}$$

$$\text{ESDv(min)} = \frac{(1.0'')(0.95)(482)}{12} = 38 \text{ CF}$$

$$\text{ESDv(max)} = \frac{(2.7'')(0.95)(482)}{12} = 103 \text{ CF}$$

$$\text{ESDv Provided} = \underline{103 \text{ CF}}$$

Lot 24:

Roof Drainage Area = 482 SF; therefore 1 drywell is proposed.

$$I = 100\%$$

$$R_v = 0.95$$

$$P_e = 1.0'' \text{ min./ } 2.7'' \text{ max.}$$

$$\text{ESDv(min)} = \frac{(1.0'')(0.95)(482)}{12} = 38 \text{ CF}$$

$$\text{ESDv(max)} = \frac{(2.7'')(0.95)(482)}{12} = 103 \text{ CF}$$

$$\text{ESDv Provided} = \underline{103 \text{ CF}}$$

Lot 25:

Roof Drainage Area = 500 SF; therefore 1 drywell is proposed.

$$I = 100\%$$

$$R_v = 0.95$$

$$P_e = 1.0'' \text{ min./ } 2.7'' \text{ max.}$$

$$\text{ESDv(min)} = \frac{(1.0'')(0.95)(500)}{12} = 40 \text{ CF}$$

$$\text{ESDv(max)} = \frac{(2.7'')(0.95)(500)}{12} = 103 \text{ CF}$$

$$\text{ESDv Provided} = \underline{103 \text{ CF}}$$

Lot 26:

Roof Drainage Area = 500 SF; therefore 1 drywell is proposed.

$$I = 100\%$$

$$R_v = 0.95$$

$$P_e = 1.0'' \text{ min./ } 2.7'' \text{ max.}$$

$$\text{ESDv(min)} = \frac{(1.0'')(0.95)(500)}{12} = 40 \text{ CF}$$

12

$$\text{ESDv(max)} = \frac{(2.7'')(0.95)(500)}{12} = 103 \text{ CF}$$

$$\text{ESDv Provided} = \underline{103 \text{ CF}}$$

Lot 27:

Roof Drainage Area = 482 SF; therefore 1 drywell is proposed.

I = 100%

Rv = 0.95

Pe = 1.0" min./ 2.7" max.

$$\text{ESDv(min)} = \frac{(1.0'')(0.95)(482)}{12} = 38 \text{ CF}$$

$$\text{ESDv(max)} = \frac{(2.7'')(0.95)(482)}{12} = 103 \text{ CF}$$

$$\text{ESDv Provided} = \underline{103 \text{ CF}}$$

Lot 28:

Roof Drainage Area = 358 SF; therefore 1 drywell is proposed.

I = 100%

Rv = 0.95

Pe = 1.0" min./ 2.7" max.

$$\text{ESDv(min)} = \frac{(1.0'')(0.95)(358)}{12} = 28 \text{ CF}$$

$$\text{ESDv(max)} = \frac{(2.7'')(0.95)(358)}{12} = 76 \text{ CF}$$

$$\text{ESDv Provided} = \underline{76 \text{ CF}}$$

Lot 29:

Roof Drainage Area = 482 SF; therefore 1 drywell is proposed.

I = 100%

Rv = 0.95

Pe = 1.0" min./ 2.7" max.

$$ESDv(min) = \frac{(1.0'')(0.95)(482)}{12} = 38 \text{ CF}$$

$$ESDv(max) = \frac{(2.7'')(0.95)(482)}{12} = 103 \text{ CF}$$

$$ESDv \text{ Provided} = \underline{103 \text{ CF}}$$

Lot 30:

Roof Drainage Area = 482 SF; therefore 1 drywell is proposed.

I = 100%

Rv = 0.95

Pe = 1.0" min./ 2.7" max.

$$ESDv(min) = \frac{(1.0'')(0.95)(482)}{12} = 38 \text{ CF}$$

$$ESDv(max) = \frac{(2.7'')(0.95)(482)}{12} = 103 \text{ CF}$$

$$ESDv \text{ Provided} = \underline{103 \text{ CF}}$$

Lot 31:

Roof Drainage Area = 1,000 SF; therefore 2 drywells are proposed, with 500 SF of roof area draining to each.

I = 100%

Rv = 0.95

Pe = 1.0" min./ 2.7" max.

$$ESDv(min) = \frac{(1.0'')(0.95)(1,000)}{12} = 79 \text{ CF}$$

$$ESDv(max) = \frac{(2.7'')(0.95)(1,000)}{12} = 213 \text{ CF}$$

$$ESDv \text{ Provided} = \underline{212 \text{ CF}}$$

Lot 36:

Roof Drainage Area = 1,000 SF; therefore 2 drywells are proposed, with 500 SF of roof area draining to each.

I = 100%

$$R_v = 0.95$$

$$P_e = 1.0'' \text{ min./ } 2.7'' \text{ max.}$$

$$ESD_v(\text{min}) = \frac{(1.0'')(0.95)(1,000)}{12} = 79 \text{ CF}$$

$$ESD_v(\text{max}) = \frac{(2.7'')(0.95)(1,000)}{12} = 213 \text{ CF}$$

$$ESD_v \text{ Provided} = \underline{212 \text{ CF}}$$

Lot 37:

Roof Drainage Area = 1,000 SF; therefore 2 drywells are proposed, with 500 SF of roof area draining to each.

$$I = 100\%$$

$$R_v = 0.95$$

$$P_e = 1.0'' \text{ min./ } 2.7'' \text{ max.}$$

$$ESD_v(\text{min}) = \frac{(1.0'')(0.95)(1,000)}{12} = 79 \text{ CF}$$

$$ESD_v(\text{max}) = \frac{(2.7'')(0.95)(1,000)}{12} = 213 \text{ CF}$$

$$ESD_v \text{ Provided} = \underline{212 \text{ CF}}$$

Lot 38:

Roof Drainage Area = 1,000 SF; therefore 2 drywells are proposed, with 500 SF of roof area draining to each.

$$I = 100\%$$

$$R_v = 0.95$$

$$P_e = 1.0'' \text{ min./ } 2.7'' \text{ max.}$$

$$ESD_v(\text{min}) = \frac{(1.0'')(0.95)(1,000)}{12} = 79 \text{ CF}$$

$$ESD_v(\text{max}) = \frac{(2.7'')(0.95)(1,000)}{12} = 213 \text{ CF}$$

ESDv Provided = 212 CF

Lot 47:

Roof Drainage Area = 1,000 SF; therefore 2 drywells are proposed, with 500 SF of roof area draining to each.

I = 100%

Rv = 0.95

Pe = 1.0" min./ 2.7" max.

$$\text{ESDv(min)} = \frac{(1.0'')(0.95)(1,000)}{12} = 79 \text{ CF}$$

$$\text{ESDv(max)} = \frac{(2.7'')(0.95)(1,000)}{12} = 213 \text{ CF}$$

ESDv Provided = 212 CF

Lot 48:

Roof Drainage Area = 2,000 SF; therefore 4 drywells are proposed, with 500 SF of roof area draining to each.

I = 100%

Rv = 0.95

Pe = 1.0" min./ 2.7" max.

$$\text{ESDv(min)} = \frac{(1.0'')(0.95)(2,000)}{12} = 158 \text{ CF}$$

$$\text{ESDv(max)} = \frac{(2.7'')(0.95)(2,000)}{12} = 427 \text{ CF}$$

ESDv Provided = 424 CF

ESDv provided from all drywells combined = 4,521 CF

2. Micro-Bioretenention – these facilities are proposed site wide, and throughout the green areas in private open space. A total of fifteen (15) micro-bioretenention facilities are proposed on-site. Each proposed micro-bioretenention facility, for this project, is capable of providing 3.3 cubic feet of ESD storage volume per square foot of facility bed area.

MB-1:

Drainage Area = 20,000 SF; 0.46 Ac.

Impervious Area = 13,460 SF; 0.31 Ac.

I = 67%

Rv = 0.65

Pe = 1.0" min./ 2.7" max.

$$\text{ESDv(min)} = \frac{(1.0'')(0.65)(20,000)}{12} = \underline{1,083 \text{ CF}}$$

$$\text{ESDv(max)} = \frac{(2.7'')(0.65)(20,000)}{12} = \underline{2,925 \text{ CF}}$$

Surface Area of facility = 782 SF

12" of ponding depth = 1 CF

54" of planting media = 1.8 CF

15" of gravel bedding = 0.5 CF

Volume provide per SF of facility = 3.3 CF/SF

ESDv(provided) = (3.3 CF x 782 SF) = 2,580 CF

MB-2:

Drainage Area = 19,267 SF; 0.44 Ac.

Impervious Area = 13,072 SF; 0.30 Ac.

I = 68%

Rv = 0.66

Pe = 1.0" min./ 2.7" max.

$$\text{ESDv(min)} = \frac{(1.0'')(0.66)(19,267)}{12} = \underline{1,060 \text{ CF}}$$

$$\text{ESDv(max)} = \frac{(2.7'')(0.66)(19,267)}{12} = \underline{2,861 \text{ CF}}$$

Surface Area of facility = 525 SF

12" of ponding depth = 1 CF

54" of planting media = 1.8 CF

15" of gravel bedding = 0.5 CF

Volume provide per SF of facility = 3.3 CF/SF

ESDv(provided) = (3.3 CF x 525 SF) = 1,732 CF

MB-2A:

Drainage Area = 7,150 SF; 0.16 Ac.  
Impervious Area = 4,120 SF; 0.09 Ac.  
I = 58%  
Rv = 0.57  
Pe = 1.0" min./ 2.7" max.

$$\text{ESDv(min)} = \frac{(1.0'')(0.57)(7,150)}{12} = \underline{340 \text{ CF}}$$

$$\text{ESDv(max)} = \frac{(2.7'')(0.57)(7,150)}{12} = \underline{917 \text{ CF}}$$

Surface Area of facility = 451 SF  
6" of ponding depth = 0.5 CF  
30" of planting media = 1 CF  
15" of gravel bedding = 0.5 CF  
Volume provide per SF of facility = 2.0 CF/SF  
ESDv(provided) = (2.0 CF x 451 SF) = 902 CF

MB-3:

Drainage Area = 17,420 SF; 0.40 Ac.  
Impervious Area = 9,106 SF; 0.21 Ac.  
I = 52%  
Rv = 0.53  
Pe = 1.0" min./ 2.7" max.

$$\text{ESDv(min)} = \frac{(1.0'')(0.53)(17,420)}{12} = \underline{770 \text{ CF}}$$

$$\text{ESDv(max)} = \frac{(2.7'')(0.53)(17,420)}{12} = \underline{2,077 \text{ CF}}$$

Surface Area of facility = 1,038 SF  
6" of ponding depth = 0.5 CF  
30" of planting media = 1 CF  
15" of gravel bedding = 0.5 CF  
Volume provide per SF of facility = 2.0 CF/SF  
ESDv(provided) = (2.0 CF x 1,038 SF) = 2,076 CF

MB-4:

Drainage Area = 17,854 SF; 0.41 Ac.  
Impervious Area = 9,109 SF; 0.21 Ac.

I = 51%

Rv = 0.51

Pe = 1.0" min./ 2.7" max.

$$\text{ESDv(min)} = \frac{(1.0'')(0.51)(17,854)}{12} = \underline{759 \text{ CF}}$$

$$\text{ESDv(max)} = \frac{(2.7'')(0.51)(17,854)}{12} = \underline{2,048 \text{ CF}}$$

Surface Area of facility = 1,451 SF

6" of ponding depth = 0.5 CF

30" of planting media = 1 CF

15" of gravel bedding = 0.5 CF

Volume provide per SF of facility = 2.0 CF/SF

ESDv(provided) = (2.0 CF x 1,420 SF) = 2,840 CF; however, the maximum that can be provided for this drainage area = 2,048 CF. Thus the facility footprint can be reduced as part of the new grading permit associated with Part 2 of the development.

#### MB-5:

Drainage Area = 19,413 SF; 0.45 Ac.

Impervious Area = 8,027 SF; 0.18 Ac.

I = 41%

Rv = 0.42

Pe = 1.0" min./ 2.7" max.

$$\text{ESDv(min)} = \frac{(1.0'')(0.42)(19,413)}{12} = \underline{680 \text{ CF}}$$

$$\text{ESDv(max)} = \frac{(2.7'')(0.42)(19,413)}{12} = \underline{1,834 \text{ CF}}$$

Surface Area of facility = 717 SF

12" of ponding depth = 1 CF

30" of planting media = 1 CF

15" of gravel bedding = 0.5 CF

Volume provide per SF of facility = 2.5 CF/SF

ESDv(provided) = (2.5 CF x 717 SF) = 1,792 CF

#### MB-6:

Drainage Area = 18,698 SF; 0.43 Ac.

Impervious Area = 8,874 SF; 0.21 Ac.

I = 47%

Rv = 0.47

Pe = 1.0" min./ 2.7" max.

$$\text{ESDv(min)} = \frac{(1.0'')(0.47)(18,698)}{12} = \underline{732 \text{ CF}}$$

$$\text{ESDv(max)} = \frac{(2.7'')(0.47)(18,698)}{12} = \underline{1,977 \text{ CF}}$$

Surface Area of facility = 949 SF

6" of ponding depth = 0.5 CF

30" of planting media = 1 CF

15" of gravel bedding = 0.5 CF

Volume provide per SF of facility = 2.0 CF/SF

ESDv(provided) = (2.0 CF x 949 SF) = 1,898 CF

MB-7:

Drainage Area = 18,307 SF; 0.42 Ac.

Impervious Area = 9,033 SF; 0.21 Ac.

I = 49%

Rv = 0.49

Pe = 1.0" min./ 2.7" max.

$$\text{ESDv(min)} = \frac{(1.0'')(0.49)(18,307)}{12} = \underline{748 \text{ CF}}$$

$$\text{ESDv(max)} = \frac{(2.7'')(0.49)(18,307)}{12} = \underline{2,018 \text{ CF}}$$

Surface Area of facility = 1,228 SF

6" of ponding depth = 0.5 CF

30" of planting media = 1 CF

15" of gravel bedding = 0.5 CF

Volume provide per SF of facility = 2.0 CF/SF

ESDv(provided) = (2.0 CF x 1,228 SF) = 2,456 CF; however, the maximum that can be provided for this drainage area = 2,018 CF. Thus the facility footprint can be reduced as part of the new grading permit associated with Part 2 of the development.

MB-8:

Drainage Area = 19,029 SF; 0.44 Ac.

Impervious Area = 11,496 SF; 0.26 Ac.

I = 60%

Rv = 0.59

Pe = 1.0" min./ 2.7" max.

$$\text{ESDv(min)} = \frac{(1.0'')(0.59)(19,029)}{12} = \underline{935 \text{ CF}}$$

$$\text{ESDv(max)} = \frac{(2.7'')(0.59)(19,029)}{12} = \underline{2,526 \text{ CF}}$$

Surface Area of facility = 536 SF

12" of ponding depth = 1 CF

54" of planting media = 1.8 CF

15" of gravel bedding = 0.5 CF

Volume provide per SF of facility = 3.3 CF/SF

ESDv(provided) = (3.3 CF x 536 SF) = 1,768 CF

MB-9:

Drainage Area = 11,554 SF; 0.27 Ac.

Impervious Area = 6,160 SF; 0.14 Ac.

I = 53%

Rv = 0.53

Pe = 1.0" min./ 2.7" max.

$$\text{ESDv(min)} = \frac{(1.0'')(0.53)(11,554)}{12} = \underline{510 \text{ CF}}$$

$$\text{ESDv(max)} = \frac{(2.7'')(0.53)(11,554)}{12} = \underline{1,377 \text{ CF}}$$

Surface Area of facility = 536 SF

12" of ponding depth = 1 CF

30" of planting media = 1 CF

15" of gravel bedding = 0.5 CF

Volume provide per SF of facility = 2.5 CF/SF

ESDv(provided) = (2.5 CF x 536 SF) = 1,340 CF

MB-10:

Drainage Area = 11,722 SF; 0.27 Ac.

Impervious Area = 6,766 SF; 0.16 Ac.

I = 58%

Rv = 0.57

Pe = 1.0" min./ 2.7" max.

$$\text{ESDv(min)} = \frac{(1.0'')(0.57)(11,722)}{12} = 557 \text{ CF}$$

$$\text{ESDv(max)} = \frac{(2.7'')(0.57)(11,722)}{12} = 1,503 \text{ CF}$$

Surface Area of facility = 620 SF

12" of ponding depth = 1 CF

30" of planting media = 1 CF

15" of gravel bedding = 0.5 CF

Volume provide per SF of facility = 2.5 CF/SF

ESDv(provided) = (2.5 CF x 620 SF) = 1,550 CF; however, the maximum that can be provided for this drainage area = 1,503 CF. Thus the facility footprint can be reduced as part of the new grading permit associated with Part 2 of the development.

MB-11:

Drainage Area = 19,777 SF; 0.45 Ac.

Impervious Area = 11,768 SF; 0.27 Ac.

I = 60%

Rv = 0.59

Pe = 1.0" min./ 2.7" max.

$$\text{ESDv(min)} = \frac{(1.0'')(0.59)(19,777)}{12} = 973 \text{ CF}$$

$$\text{ESDv(max)} = \frac{(2.7'')(0.59)(19,777)}{12} = 2,625 \text{ CF}$$

Surface Area of facility = 547 SF

12" of ponding depth = 1 CF

54" of planting media = 1.8 CF

15" of gravel bedding = 0.5 CF

Volume provide per SF of facility = 3.3 CF/SF

ESDv(provided) = (3.3 CF x 547 SF) = 1,805 CF

MB-12:

Drainage Area = 20,000 SF; 0.46 Ac.

Impervious Area = 15,091 SF; 0.35 Ac.

I = 75%

$$R_v = 0.73$$

$$P_e = 1.0'' \text{ min./ } 2.7'' \text{ max.}$$

$$ESD_v(\text{min}) = \frac{(1.0'')(0.73)(20,000)}{12} = \underline{1,217 \text{ CF}}$$

$$ESD_v(\text{max}) = \frac{(2.7'')(0.73)(20,000)}{12} = \underline{3,285 \text{ CF}}$$

Surface Area of facility = 2,173 SF

6" of ponding depth = 0.5 CF

30" of planting media = 1 CF

15" of gravel bedding = 0.5 CF

Volume provide per SF of facility = 2.0 CF/SF

$ESD_v(\text{provided}) = (2.0 \text{ CF} \times 2,173 \text{ SF}) = 4,346 \text{ CF}$ ; however, the maximum that can be provided for this drainage area = 3,285 CF. Thus the facility footprint can be reduced as part of the new grading permit associated with Part 2 of the development.

#### MB-13:

Drainage Area = 15,284 SF; 0.35 Ac.

Impervious Area = 11,321 SF; 0.26 Ac.

$$I = 74\%$$

$$R_v = 0.72$$

$$P_e = 1.0'' \text{ min./ } 2.7'' \text{ max.}$$

$$ESD_v(\text{min}) = \frac{(1.0'')(0.72)(15,284)}{12} = \underline{917 \text{ CF}}$$

$$ESD_v(\text{max}) = \frac{(2.7'')(0.72)(15,284)}{12} = \underline{2,476 \text{ CF}}$$

Surface Area of facility = 377 SF

12" of ponding depth = 1 CF

54" of planting media = 1.8 CF

15" of gravel bedding = 0.5 CF

Volume provide per SF of facility = 3.3 CF/SF

$$ESD_v(\text{provided}) = (3.3 \text{ CF} \times 377 \text{ SF}) = \underline{1,244 \text{ CF}}$$

#### MB-14:

Drainage Area = 16,011 SF; 0.37 Ac.

Impervious Area = 9,894 SF; 0.23 Ac.

$$I = 62\%$$

$$R_v = 0.61$$

$$P_e = 1.0'' \text{ min./ } 2.7'' \text{ max.}$$

$$ESD_v(\text{min}) = \frac{(1.0'')(0.61)(16,011)}{12} = \underline{814 \text{ CF}}$$

$$ESD_v(\text{max}) = \frac{(2.7'')(0.61)(16,011)}{12} = \underline{2,197 \text{ CF}}$$

$$\text{Surface Area of facility} = 356 \text{ SF}$$

$$12'' \text{ of ponding depth} = 1 \text{ CF}$$

$$54'' \text{ of planting media} = 1.8 \text{ CF}$$

$$15'' \text{ of gravel bedding} = 0.5 \text{ CF}$$

$$\text{Volume provide per SF of facility} = 3.3 \text{ CF/SF}$$

$$ESD_v(\text{provided}) = (3.3 \text{ CF} \times 356 \text{ SF}) = \underline{1,174 \text{ CF}}$$

$$\underline{ESD_v \text{ provided from all mirco-bioretenction combined} = 27,165 \text{ CF}}$$

3. Infiltration Trenches – these facilities are proposed in two areas along the Private North Alley. Porous paving was originally proposed for the Private North Alley, but has been removed at the request of the City of Annapolis. Given the extremely limited green space on-site, alternative ESD facilities were considered, but ultimately determined not to be feasible. The current stormwater plan proposes two (2) subsurface infiltration trenches to treat runoff from the Private North Alley. Storage volume calculations are as follows:

IT-1:

$$\text{Drainage Area} = 18,541 \text{ SF; } 0.43 \text{ Ac.}$$

$$\text{Impervious Area} = 11,930 \text{ SF; } 0.27 \text{ Ac.}$$

$$I = 64\%$$

$$R_v = 0.63$$

$$P_e = 1.0'' \text{ min./ } 2.7'' \text{ max.}$$

$$ESD_v(\text{min}) = \frac{(1.0'')(0.63)(18,541)}{12} = \underline{973 \text{ CF}}$$

$$ESD_v(\text{max}) = \frac{(2.7'')(0.63)(18,541)}{12} = \underline{2,628 \text{ CF}}$$

Infiltration Trench Dimensions

$$L = 100 \text{ Ft.}$$

$$W = 10 \text{ Ft.}$$

H = 4 Ft.  
Porosity (n) of gravel = 0.40 (40%)

Storage volume within IT-1 =  $(4 \times 10 \times 100 \times 0.40) = \underline{1,600 \text{ CF}}$

IT-2:

Drainage Area = 21,182 SF; 0.49 Ac.  
Impervious Area = 14,044 SF; 0.32 Ac.  
I = 66%  
Rv = 0.64  
Pe = 1.0" min./ 2.7" max.

ESDv(min) =  $\frac{(1.0'')(0.64)(21,182)}{12} = \underline{1,130 \text{ CF}}$

ESDv(max) =  $\frac{(2.7'')(0.64)(21,182)}{12} = \underline{3,050 \text{ CF}}$

Infiltration Trench Dimensions

L = 100 Ft.  
W = 10 Ft.  
H = 4 Ft.  
Porosity (n) of gravel = 0.40 (40%)

Storage volume within IT-1 =  $(4 \times 10 \times 100 \times 0.40) = \underline{1,600 \text{ CF}}$

ESDv provided from all infiltration trenches combined = 3,200 CF

**SITE STORMWATER MANAGEMENT CONCLUSION**

ESD SUMMARY TABLE		
	Required	Provided
Environmental Site Design Volume	29,606 CF	34,886 CF (118%)*

\*Environmental Site Design is provided to the Maximum Extent Practicable (MEP)

The total ESD storage volume provided across the Aris T. Allen residential site is **34,886 CF**, 118% of the required ESD storage volume. Through a combination of the ESD facilities outlined above, it is concluded that that Environmental Site Design is provided to the Maximum Extent Practicable (MEP).

## **APPENDIX**

**Table 5.3** Rainfall Targets/Runoff Curve Number Reductions used for ESD

Hydrologic Soil Group A										
%I	RCN*	P <sub>E</sub> = 1"	1.2"	1.4"	1.6"	1.8"	2.0"	2.2"	2.4"	2.6"
0%	40									
5%	43									
10%	46									
15%	48	38								
20%	51	40	38	38						
25%	54	41	40	39						
30%	57	42	41	39	38					
35%	60	44	42	40	39					
40%	61	44	42	40	39					
45%	66	48	46	41	40					
50%	69	51	48	42	41	38				
55%	72	54	50	42	41	39				
60%	74	57	52	44	42	40	38			
65%	77	61	55	47	44	42	40			
70%	80	66	61	55	50	45	40			
75%	84	71	67	62	56	48	40	38		
80%	86	73	70	65	60	52	44	40		
85%	89	77	74	70	65	58	49	42	38	
90%	92	81	78	74	70	65	58	48	42	38
95%	95	85	82	78	75	70	65	57	50	39
100%	98	89	86	83	80	76	72	66	59	40

Hydrologic Soil Group B										
%I	RCN*	P <sub>E</sub> = 1"	1.2"	1.4"	1.6"	1.8"	2.0"	2.2"	2.4"	2.6"
0%	61									
5%	63									
10%	65									
15%	67	55								
20%	68	60	55	55						
25%	70	64	61	58						
30%	72	65	62	59	55					
35%	74	66	63	60	56					
40%	75	66	63	60	56					
45%	78	68	66	62	58					
50%	80	70	67	64	60					
55%	81	71	68	65	61	55				
60%	83	73	70	67	63	58				
65%	85	75	72	69	65	60	55			
70%	87	77	74	71	67	62	57			
75%	89	79	76	73	69	65	59			
80%	91	81	78	75	71	66	61			
85%	92	82	79	76	72	67	62	55		
90%	94	84	81	78	74	70	65	59	55	
95%	96	87	84	81	77	73	69	63	57	
100%	98	89	86	83	80	76	72	66	59	55

 Cp<sub>v</sub> Addressed (RCN = Woods in Good Condition)

 RCN Applied to Cp<sub>v</sub> Calculations

**Table 5.3** Runoff Curve Number Reductions used for Environmental Site Design (continued)

Hydrologic Soil Group C										
%I	RCN*	P <sub>E</sub> = 1"	1.2"	1.4"	1.6"	1.8"	2.0"	2.2"	2.4"	2.6"
0%	74									
5%	75									
10%	76									
15%	78									
20%	79	70								
25%	80	72	70	70						
30%	81	73	72	71						
35%	82	74	73	72	70					
40%	84	77	75	73	71					
45%	85	78	76	74	71					
50%	86	78	76	74	71					
55%	86	78	76	74	71	70				
60%	88	80	78	76	73	71				
65%	90	82	80	77	75	72				
70%	91	82	80	78	75	72				
75%	92	83	81	79	75	72				
80%	93	84	82	79	76	72				
85%	94	85	82	79	76	72				
90%	95	86	83	80	77	73	70			
95%	97	88	85	82	79	75	71			
100%	98	89	86	83	80	76	72	70		

Hydrologic Soil Group D										
%I	RCN*	P <sub>E</sub> = 1"	1.2"	1.4"	1.6"	1.8"	2.0"	2.2"	2.4"	2.6"
0%	80									
5%	81									
10%	82									
15%	83									
20%	84	77								
25%	85	78								
30%	85	78	77	77						
35%	86	79	78	78						
40%	87	82	81	79	77					
45%	88	82	81	79	78					
50%	89	83	82	80	78					
55%	90	84	82	80	78					
60%	91	85	83	81	78					
65%	92	85	83	81	78					
70%	93	86	84	81	78					
75%	94	86	84	81	78					
80%	94	86	84	82	79					
85%	95	86	84	82	79					
90%	96	87	84	82	79	77				
95%	97	88	85	82	80	78				
100%	98	89	86	83	80	78	77			

Cp<sub>v</sub> Addressed (RCN = Woods in Good Condition)

RCN Applied to Cp<sub>v</sub> Calculations